

CLAIMS

1. A battery connection detection circuit for detecting whether a secondary battery is operable and  
5 whether the secondary battery is reliably connected to a charging device, comprising:

a current supplying circuit configured to supply a current to the secondary battery;

a constant voltage circuit configured to  
10 control the current from the current supplying circuit so that a voltage on a connection terminal T1 for connecting the secondary battery is constant;

a constant current circuit configured to control the current from the current supplying circuit so  
15 that the current supplied to the secondary battery is constant; and

a determination circuit configured to determine operation states of the constant voltage circuit and the constant current circuit, said  
20 determination circuit determining whether the secondary battery is operable and whether the secondary battery is reliably connected to the charging device according to the operation states of the constant voltage circuit and the constant current circuit.

2. The battery connection detection circuit as claimed in claim 1, wherein

the determination circuit determines an operation state of a load circuit that receives power supply from the secondary battery; and

when it is detected that the load circuit does not consume a current, the determination circuit determines whether the secondary battery is operable and whether the secondary battery is reliably connected to the charging device according to the operation states of the constant voltage circuit and the constant current circuit.

3. The battery connection detection circuit as claimed in claim 1, wherein when it is determined that the voltage on the connection terminal T1 is lower than a predetermined value from the operation state of the constant current circuit, or the current flowing through the secondary battery is higher than a predetermined value from the operation state of the constant current circuit, the determination circuit determines the secondary battery is operable and the secondary battery is reliably connected to the connection terminal T1.

4. The battery connection detection circuit as

claimed in claim 1, wherein

the current supplying circuit includes a  
current control transistor that controls the current  
supplied to the secondary battery according to a control  
5 signal input to a control electrode thereof;

the constant voltage circuit includes

a voltage detection circuit that detects the  
voltage on the connection terminal T1 and outputs a  
voltage Vd1 proportional to the detected voltage,  
10 a first calculation amplification circuit  
into which the output voltage Vd1 from the voltage  
detection circuit and a first reference voltage Vs1 are  
input, and

a first control transistor whose operation  
15 is controlled according to an output signal CV from the  
first calculation amplification circuit;

the constant current circuit includes

a current detection circuit that converts  
the current supplied by the current supplying circuit  
20 into a voltage and outputs the voltage,

a second calculation amplification circuit  
into which the output voltage from the current detection  
circuit and a second reference voltage Vs2 are input, and

a second control transistor whose operation  
25 is controlled according to an output signal CC from the

second calculation amplification circuit; and

the current control transistor controls the current supplied to the secondary battery according to operations of the first control transistor and the second  
5 control transistor.

5. The battery connection detection circuit as claimed in claim 1, wherein

the current supplying circuit includes a  
10 current control transistor that controls the current supplied to the secondary battery according to a control signal input to a control electrode thereof;

the constant voltage circuit includes

a voltage detection circuit that detects the  
15 voltage on the connection terminal T1 and outputs a voltage Vd1 proportional to the detected voltage,

a switching circuit that exclusively selects one of a plurality of input reference voltages Vrl to Vrn according to an input control signal Sc1, and outputs the  
20 selected reference voltage as a first reference voltage Vs1,

a first calculation amplification circuit into which the output voltage Vd1 from the voltage detection circuit and the first reference voltage Vs1 are  
25 input, and

a first control transistor whose operation is controlled according to an output signal CV from the first calculation amplification circuit;

the constant current circuit includes

5 a current detection circuit that converts the current supplied by the current supplying circuit into a voltage and outputs the voltage,

a second calculation amplification circuit into which the output voltage from the current detection circuit and a second predetermined reference voltage Vs2 are input, and

a second control transistor whose operation is controlled according to an output signal CC from the second calculation amplification circuit; and

15 the current control transistor controls the current supplied to the secondary battery according to operations of the first control transistor and the second control transistor.

20 6. The battery connection detection circuit as claimed in claim 4, wherein the operation state of the constant voltage circuit corresponds to a state of the output signal CV from the first calculation amplification circuit; and

25 the operation state of the constant current

circuit corresponds to a state of the output signal CC from the second calculation amplification circuit.

7. The battery connection detection circuit as  
5 claimed in claim 4, wherein the current control transistor includes a MOS transistor.

8. The battery connection detection circuit as  
claimed in claim 4, wherein the current control  
10 transistor includes a bipolar transistor.

9. The battery connection detection circuit as  
claimed in claim 4, wherein the determination circuit  
determines the secondary battery is operable and the  
15 secondary battery is reliably connected to the connection terminal T1, when the output signal CV from the first calculation amplification circuit indicates that the output voltage Vd1 from the voltage detection circuit is lower than the first reference voltage Vs1, or when the  
20 output signal CC from the second calculation amplification circuit indicates that the output voltage from the current detection circuit is higher than or equal to the second reference voltage Vs2.

25 10. The battery connection detection circuit

as claimed in claim 1, wherein the current supplying circuit, the constant voltage circuit, the constant current circuit, and the determination circuit are integrated in one Integrated Circuit (IC).

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11. The battery connection detection circuit as claimed in claim 1, wherein the current supplying circuit, the constant voltage circuit, the constant current circuit, the determination circuit, and the load  
10 circuit are integrated in one Integrated Circuit (IC).